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NOTES ON THE DISTRIBUTION AND COMPARATIVE LEAF MORPHOLOGY OF THE ACAULESCENT SPECIES OF *STRELITZIA* AIT.

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Abstract

Plants of *S. reginae* encountered in the wild represent a wide variety of leaf shapes and sizes. The junceous form of *Strelitzia* cannot be regarded as part of this variation as it is a distinct morphological entity found in extensive stands in the Uitenhage and Port Elizabeth areas. Seedlings of these two growth forms, which were raised in a growth cabinet, show morphological and ontogenetic differences right from the early growth stages. It is therefore proposed that *S. juncea* be regarded as a seperate species.

A population containing a variety of leaf forms intermediate between *S. reginae* and *S. juncea* was encountered near Patensie. The possibility that these plants are *S. reginae* × *S. juncea* hybrids needs to be investigated.

Although odd clones approximating the description of *S. parvifolia* do exist in the wild, the data presented in this paper suggest that this growth form does not merit specific rank.

Uittreksel

AANTEKENINGE OOR DIE VERSPREIDING EN VERGELYKENDE BLAARMORFOLOGIE VAN DIE ONGESTINGELDE SPESIES VAN *STRELITZIA* AIT.

Plante van *S. reginae* wat in die veld aangetref word, verteenwoordig 'n groot verskeidenheid van blaargroottes en -vorms. Die biesieagtige groeivorm van *Strelitzia* kan nie as deel van hierdie variasie beskou word nie aangesien dit 'n eiesoortige morfologiese entiteit is wat in uitgebreide stande in die Uitenhage en Port Elizabeth omgewings voorkom. Saailinge van hierdie twee groeivorms, wat in 'n groeikabinet gekweek is, het vanaf die vroegste groeistadia verskil ten opsigte van hul morfologie en ontogenetiese ontwikkeling. Dit word dus voorgestel dat *S. Juncea* as 'n afsonderlike spesie beskou word.

'n Bevolking wat naby Patensie aangetref is, bevat 'n verskeidenheid van blaarvorms intermediêr tussen die van *S. reginae* en *S. juncea*. Die moontlikheid dat hierdie plante *S. reginae* × *S. juncea* basters is, regverdig verdere navorsing.

Alhoewel enkele klone wat aan die beskrywing van *S. parvifolia* voldoen, wel in die veld aangetref word, dui die gegewens wat in hierdie artikel aangebied word, daarop dat hierdie groeivorm nie as 'n afsonderlike spesie erken behoort te word nie.

Introduction

Two acaulescent species of *Strelitzia* are described in *Flora Capensis* (Wright, 1913) namely, *Strelitzia reginae* Ait. and *S. parvifolia* Ait.

Strelitzia reginae is described as having leaf blades approximately 45 cm (1,5 ft) long and 10 cm (4 in) wide with the margins undulate, especially in the lower part. Five varieties are differentiated on the basis of characteristics such as lamina shape and size and petiole length. Four of these varieties are known from cultivated specimens only.

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Strelitzia parvifolia is distinguished from *S. reginae* on the basis of lamina size. The leaf blade of this species is reported to be approximately 23 cm (9 in) long and 7,5 cm (3 in) wide. The lamina has a flat margin. Only one variety (var. *juncea* Ker-Gawler) is listed and is described as a form which has either a very small leaf blade, or none at all.

Moore and Hyypio (1970) expressed the opinion that only one acaulescent species should be recognised, namely *S. reginae*. They suggest that as there are no discernible characters of the flower to separate *S. parvifolia* from *S. reginae*, and as this form probably represents no more than an anomalous clone of *S. reginae*, *S. parvifolia* does not merit specific rank.

Moore and Hyypio (1970) mention that the variant with no leaf blade was described independently in 1821 as *S. juncea* Link and *S. parvifolia* var. *juncea* Ker-Gawler, both from plants in cultivation. As distinctions from *S. reginae* other than in the lack of leaf blade are not apparent, and as its distribution in South Africa is not well documented, Moore and Hyypio decided to reduce *S. juncea* to *S. reginae* where, if desired, it could be designated as a cultivar—cv. 'Juncea'.

Dr. R. A. Dyer of the Botanical Research Institute in Pretoria (personal communication) felt that this treatment was too drastic. In a publication on the vegetative multiplication of the acaulescent species of *Strelitzia*, Dyer (1972) recognizes two species, namely *S. reginae* Ait. and *S. juncea* Link.

In view of these conflicting opinions a study of the distribution and leaf morphology of *S. reginae* and its allies was undertaken.

MATERIALS AND METHODS

Various field trips were undertaken to examine *Strelitzia* species growing in the wild. Using data obtained in this way, as well as data made available by various herbaria, a distribution map of the acaulescent species was compiled. The opportunity was also used to plot the distribution of the caulescent species.

To permit morphological comparisons on a rational basis, measurement of various parameters (see Table 1) were taken on plants growing at three localities. The following growth forms were compared in this way:

(a) Plants growing in Pluto's Vale, 4 km from Ecca Pass (approximately 26 km from Grahamstown). Although a fair amount of variation in lamina shape and size was encountered in this population, the plants were all regarded as specimens of *S. reginae* because of the presence of a prominent leaf blade. None of the plants resembled the junceous form encountered in the Uitenhage area.

(b) Plants growing on the farm Brackhill, 26 km from Uitenhage on the national road to Graaff-Reinet. These plants were very typical of the various uniform *Strelitzia* populations to be found in this area. The leaves on all the plants either have extremely reduced laminae, or none at all. These plants are referred to as *S. juncea* in this text. None of the plants in this area were morphologically identical to any of the plants found at Pluto's Vale.

(c) Plants growing in the Vensterhoek area about 16 km from Patensie. A variety of growth forms was encountered in this population. Some of the plants resembled the *S. reginae* specimens at Pluto's Vale, others were similar to the junceous form found in the Uitenhage area, while a host of other plants was found with laminae of intermediate shapes and sizes.

The acaulescent species of *Strelitzia* occur in the wild as isolated "clumps" (see Fig. 3). These specimens are not individual plants, as they superficially appear to be, but are a group of plants which have resulted from the vegetative multiplication of the original parent plant as described by Dyer (1972). The individual clumps encountered in the field will subsequently be referred to as clones.

Measurements were taken on ten randomly selected leaves and inflorescences in each clone. At Pluto's Vale and Brackhill the survey was conducted on twenty randomly selected clones and mean values computed. Due to the striking variations in leaf morphology of plants growing at Venterhoek, the values recorded at this locality represent means from individual clones.

As environmental differences may result in morphological differences, a comparison of plants of *S. juncea* and *S. reginae* grown under identical conditions in a growth cabinet was also made. For this purpose seeds of *S. reginae* were collected from plants growing in the veld near East London while those of *S. juncea* were collected in the Uitenhage area. In both cases the plants were not growing near any differing growth forms so that the possibility that cross-pollination with such forms could have taken place was negligable.

The seeds were germinated aseptically in petri dishes and the seedlings transferred to a vermiculite substrate in plastic containers of one litre capacity. As growth proceded the plants were transplanted to larger pots. Nutrients were supplied by means of biweekly applications of a complete nutrient solution. The relative proportions of the different macro-elements in the solution were based on the formulation used by Murray (1959) for *Musa* species.

The plants were grown in a Percival model PGW-132 growth cabinet at day/night temperatures of 26/18 °C. A photoperiod of 14 hours with a light intensity of approximately 20 000 lux was maintained.

Leaf measurement of the plants were taken from time to time.

RESULTS

The distribution of *Strelitzia* species in South Africa is depicted in Fig. 1.

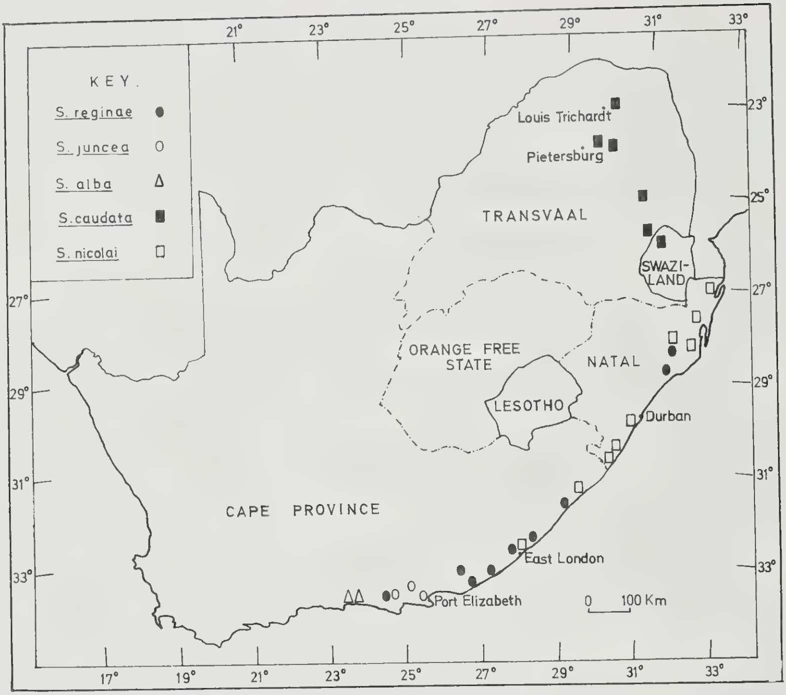


FIG. 1.
Distribution of *Strelitzia* species in South Africa.

The herbarium specimens used in the compilation of this map are listed in the appendix.

S. reginae

This species is distributed along the east coast of South Africa from Patensie to Zululand. It could not be ascertained whether the plant has ever been found in the wild on the south coast of Natal.

The largest populations of this species were found at Ecca Pass and Pluto's Vale, near Grahamstown. The average size of laminae in the Pluto's Vale population was found to be smaller than the size recorded in *Flora Capensis* for the species. In Table 1 it can be seen that the mean lamina length was 33 cm and mean lamina width 10 cm. However, a large amount of variation in leaf size was found. A clone with laminae on the average 41 cm long and 5 cm wide was encountered as well as one with laminae 29 cm long and 8,5 cm wide.

In Fig. 2 an extreme example is pictured—leaf blades 30 cm long and 3 cm wide.

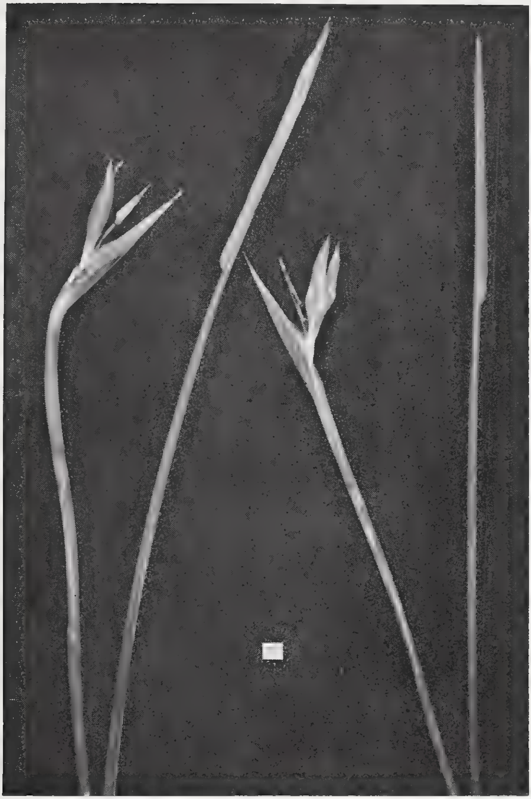


FIG. 2.
Leaves and flowers of a *S. reginae* clone found at Pluto's Vale.

Considerable variation in lamina size, as well as lamina shape, was also encountered among *S. reginae* plants growing elsewhere. It would seem that leaf size is influenced to a large degree by environmental conditions. Plants in the wild growing in dense bush or a clump of trees invariably have abnormally long petioles—and yet this is a criterion which is used to differentiate between varieties in *Flora Capensis*. Plants in cultivation often grow to a greater height than those found in the wild.

TABLE 1—Some dimensions (in cm) of three populations* of acaulescent growth forms of *Strelitzia*

Locality	Pluto's Vale	Brackhill	Vensterhoek							
Species	*S. reginae*	*S. juncea*	*S. reginae*	*S. juncea*	Intermediate forms					
Clone height (length of longest leaf)	142	195	140	160	170	200	160	170	170	190
Clone diameter (ground level)	153	90	150	50	400	140	75	120	200	130
Total length of leaf	108	165	127	135	137	146	134	136	148	169
Petiole length	75	165	98	130	124	124	114	125	140	153
Lamina length	33	**	29	5**	13	22	20***	11**	8**	16**
Lamina width	10		11	0,5	4,5	3	2	1,5	1	0,5
Scape length	88	104	107	97	—	94	110	108	83	96
Spathe length	20	20	24	21	—	19	20	18	18	20
Number of inflorescences per clone	12	13	6	7	0	8	3	2	7	12

* Values for Pluto's Vale and Brackhill represent averages from 20 clones.
Values for Vensterhoek represent measurements of individual clones.

** Leaf apices normally sclerotic.

*** Leaf apices slightly sclerotic.

In the light of the extensive variation in leaf shape and size of plants of *S. reginae*, two points may be emphasized:

(a) It is meaningless to delineate the species in terms of leaf shape and size unless very wide limits are set.

(b) The indescriminate recognition of varieties on the basis of criteria such as these, especially from plants in cultivation, can serve no useful purpose and only lead to confusion.

S. juncea

An acaulescent form of *Strelitzia* which is quite distinct from *S. reginae* as far as appearance is concerned, occurs in relatively extensive stands at different localities north west of Uitenhage. Two populations are also located in the Port Elizabeth area; one at Coega Kop and the other in Gelanse Kloof. Junceous forms are also found at Vensterhoek.

Plants of this species have a bizarre appearance (see Fig. 3). The foliage consists of long, erect petioles which, as a rule, have sclerotic apices (d in Fig. 4). In some cases the petiole tip dies back for a considerable distance (e in Fig. 4).

When viewed from a distance, all the leaves of this growth form seem to be devoid of laminae. On closer examination, however, it can be seen that the

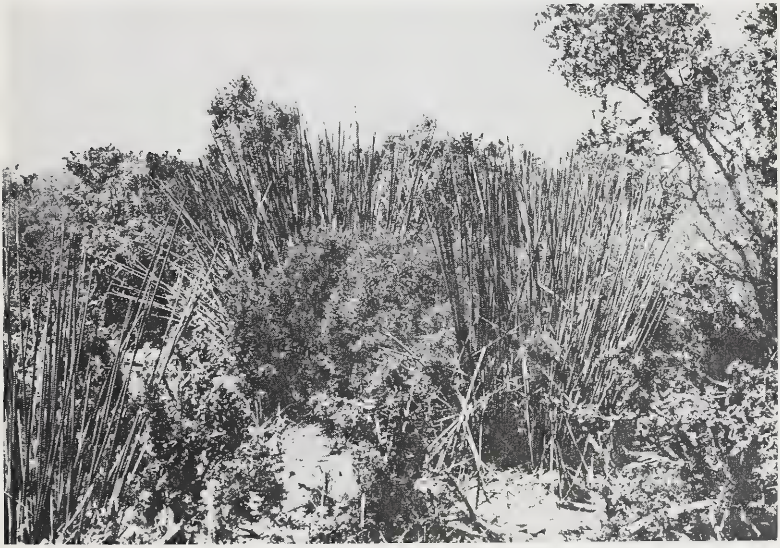


FIG. 3.
Clones of *S. juncea* in the veld near Uitenhage.

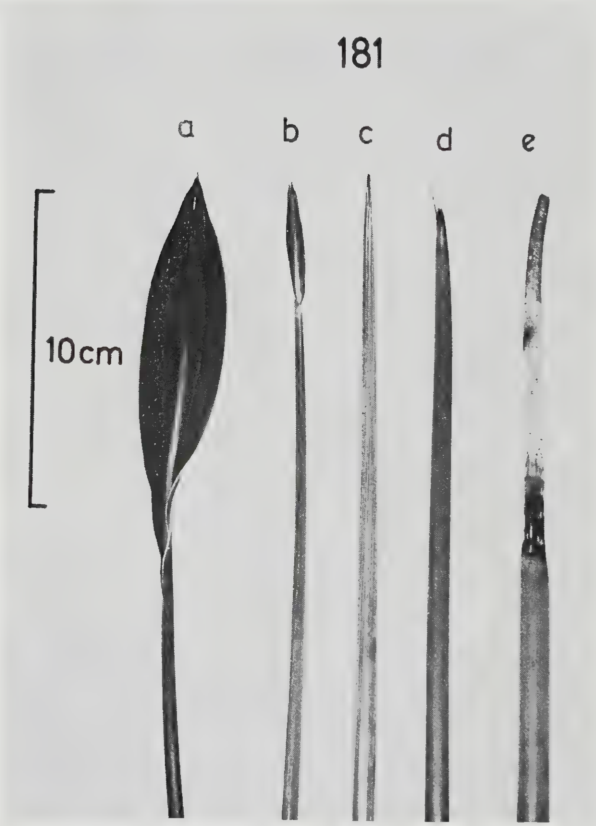


FIG. 4.
Leaf-forms encountered on *S. juncea* plants.

petioles of some of the plants support a very small lamina which is approximately 4 cm long and 0,5 cm wide (b in Fig. 4). Some leaves do not have small laminae or sclerotic tips, but only a small groove in the petiole apex (c in Fig. 4).

Leaves with laminae measuring approximately 10 cm by 2–4 cm are also encountered on *S. juncea* plants (a in Fig. 4). Such laminae are occasionally found on mature plants and are carried on very short petioles. They are commonly seen, however, as regrowth after the foliage of mature plants has been cut down to almost ground level. As seedlings of *S. juncea* produce leaves which are distinctly laminate (see Fig. 5), the large lamina probably represents a juvenile leaf form.

The data in Table 1 show that the *S. juncea* plants examined were taller than the plants of *S. reginae*. Although these figures were obtained from plants growing at different localities and are, therefore, not strictly comparable, they probably do reflect genetic differences. Where the two species are cultivated in close proximity, such as at Kirstenbosch and in various parks in Port Elizabeth, it can be seen that the plants of *S. juncea* are invariably taller than those of *S. reginae*.

The leaves of plants of *S. juncea* at Brackhill were almost 60 cm longer than leaves of *S. reginae* plants in Pluto's Vale (see Table 1). It is also important to note that the average leaf length of 165 cm in the case of *S. juncea* actually represents the length of the petiole only. In the case of *S. reginae*, the average leaf length of 108 cm includes 75 cm of lamina. The petioles of these plants are therefore less than half as long as the petioles of *S. juncea*.

Although measurements were not taken of any of the plants growing in the Port Elizabeth area, these plants seem to resemble those growing near Uitenhage in all respects.

Growth forms at Vensterhoek

A very interesting population of acaulescent *Strelitzia* plants was encountered at Vensterhoek near Patensie. In this rather scattered population are plants which resemble *S. reginae* as well as plants which resemble *S. juncea*. The reduced laminae of the junceous plants are, however, slightly longer than is the case for plants of this form in the Uitenhage area. The junceous forms at Vensterhoek frequently have leaves which have died back from the tip so that only the sclerotic remains of these laminae are seen.

Also to be found in this population are plants representing a large variety of lamina shapes and sizes. Some of these plants are described by the data in Table 1 and it can be seen that some clones have laminae of unusual proportions in comparison with laminae of "typical" *S. reginae* and *S. juncea* plants.

The variation found at Vensterhoek is reminiscent of the so-called "hybrid scatter" which occurs after cross-pollination between species. It is possible that these intermediate forms are *S. reginae* × *S. juncea* hybrids. This possibility will be investigated in the near future.

S. parvifolia

As far as could be ascertained, there are no herbarium specimens of this species in South Africa. The only record of the species which could be traced is a photograph of a specimen in the herbarium of the Royal Botanic Gardens at Kew. The lamina of this specimen is approximately 22 cm long and 4 cm wide. The only clue as to locality is the annotation "Cape". It is interesting that *Flora Capensis* does not mention any specific locality for this species either.

No uniform stand of plants conforming to the description of *S. parvifolia* or resembling the specimen at Kew were encountered anywhere in the veld. There are, no doubt, clones at Pluto's Vale and Vensterhoek which would fit the description of *S. parvifolia*. However, in the light of the variation between the different clones it would be ridiculous to accept any such variant as a separate species.

No other conclusion can be drawn but that *S. parvifolia* does not merit specific rank. This is in agreement with the opinion of Moore and Hyypio (1970).

Comparative morphology of seedlings in a controlled environment

No differences in external morphology are evident as far as germinating seeds of *S. reginae* and *S. juncea* are concerned. Differences are, however, apparent in the seedlings which develop from these seeds.

The laminae of *S. reginae* seedlings are larger than those of *S. juncea*, a difference which can be seen even after the lamina of the first laminate leaf has extended (see Fig. 5a).

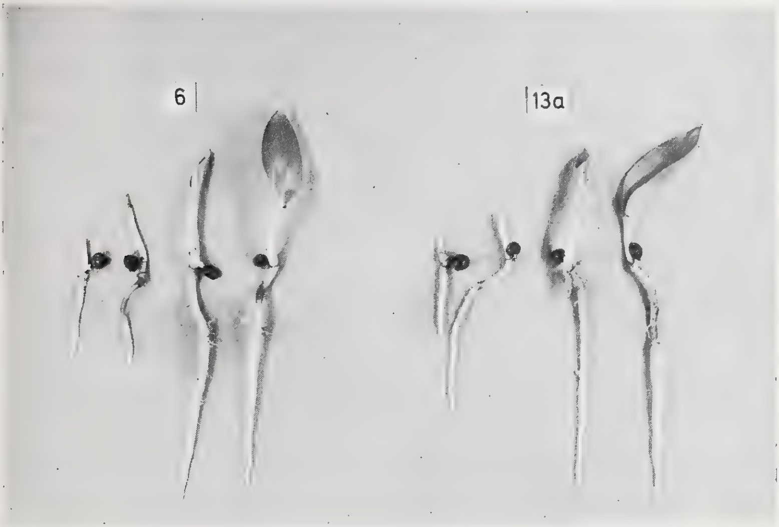
As successive leaves of *S. reginae* seedlings appear, a progressive increase in lamina size is found. A different pattern of development is encountered in seedlings of *S. juncea*. (See Figs. 5 and 6).

Laminae of *S. juncea* seedlings show an increase in size only up to about the eighth leaf, depending on the individual seedling. Hereafter successive leaves show a progressive decline in lamina size. The lamina of the twelfth leaf of the *S. juncea* specimen shown in Fig. 5c (that is, the longest leaf shown in the figure) is barely visible and is typical of laminae found on mature plants of *S. juncea*. This lamina was found to be 4,0 cm long and 0,7 cm wide.

The first few leaves of *S. reginae* have longer petioles than the corresponding leaves on *S. juncea* seedlings. From the eighth leaf onwards, however, *S. juncea* produces longer petioles than *S. reginae*.

All the leaves of *S. juncea* have a higher ratio of petiole length to lamina length in comparison with leaves of *S. reginae*. The tenth leaf of *S. juncea* plants, for instance, has a petiole which is, on the average 4,89 times longer than the lamina. The petiole of the tenth leaf of *S. reginae* plants is only 1,38 times longer than the lamina. The twelfth leaf of the *S. juncea* specimen pictured in Fig. 5 has a petiole length: lamina length ratio of 20.

Differences in lamina shape between the two species were also recorded. The laminae of *S. juncea* are generally elliptic. The first few leaves of *S. reginae* also have an elliptic form while those appearing later are decidedly lanceolate.



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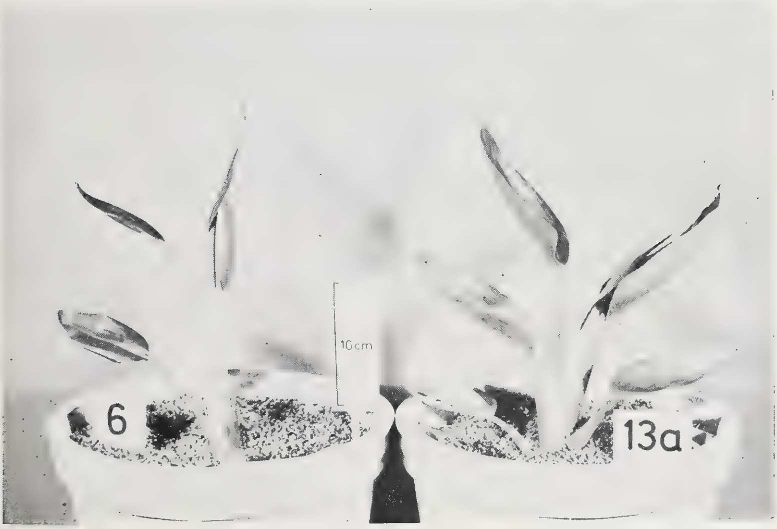

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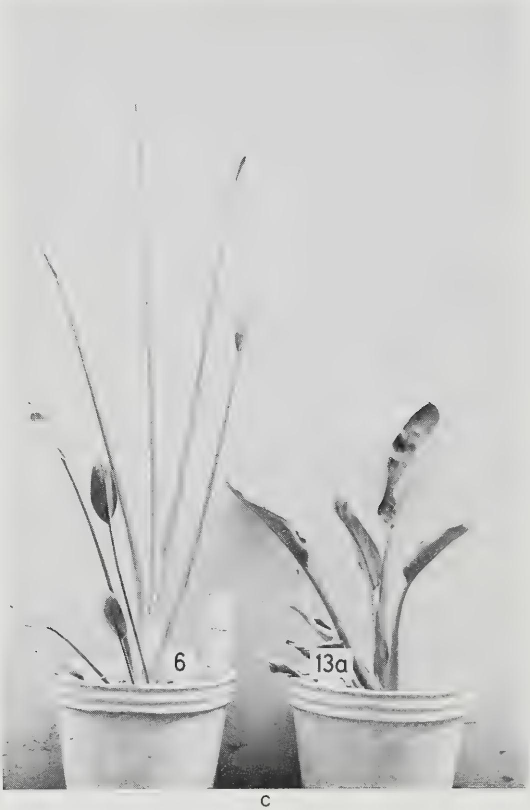

Fig. 5.
Comparison of growth of seedlings of *S. juncea* (no. 6) and *S. reginae* (no. 13a) in a controlled environment a. Germinating seeds; b. Plants after eight months of growth; c. Plants after 15,5 months of growth.

Discussion

The data presented in this paper confirm the view of Moore and Hyypio (1970) that *S. parvifolia* does not merit recognition at specific level. Plants of *S. reginae* encountered in the wild exhibit a wide range of leaf shapes and sizes and some of these clones probably approximate the description of *S. parvifolia* as recorded in *Flora Capensis*.

The junceous form cannot be regarded as part of the variation within *S. reginae*. It is a distinct morphological entity and can be distinguished from

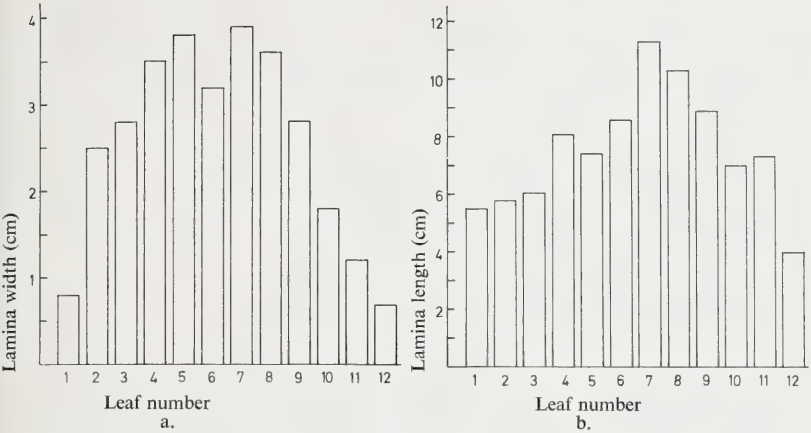

FIG. 6.
Lamina measurements of a young *S. juncea* plant a. Lamina width b. Lamina length.

S. reginae under a wide range of environmental conditions. The ontogenetic development of the plants also differs from the early growth stages of the seedlings.

The distribution of *S. juncea* is also distinct from that of *S. reginae*. Apart from plants in cultivation, a mixed stand of the two species was only found at one locality, namely Vensterhoek. Admittedly the various growth forms found at this locality do present a classification problem and further research is required on this population. The possibility that these intermediate growth forms could be *S. reginae* × *S. juncea* hybrids needs to be investigated. Apart from cross-pollination studies, the approach of Fröst and Bose (1966) and Fröst and Ising (1968) using chemical systematic methods might prove valuable in this respect.

Attempts at a cytological comparison of *S. reginae* and *S. juncea* have been made but the mitotic figures obtained so far have not been sufficiently clear to justify a definite conclusion.

In the light of the data presented in this paper it is suggested that the junceous form maintains the name *S. juncea* Link. Furthermore, it is proposed that the key presented by Moore and Hyypio (1970) be modified with respect to the acaulescent species of *Strelitzia*. The following is proposed:

Flowers with orange to yellow sepals and deep blue-violet petals; penduncles of inflorescences elongate, erect from the leaf axils; erect stems not developed.

Leaf blades prominent, at least 3 cm wide and 30 cm long, usually wider and longer (1) *S. reginae*

Leaf blades absent, or very reduced. Petioles usually terminate in dead apex. (2) *S. juncea*

In the case of *S. reginae* such a diversity of lamina shapes and sizes is encountered that it would hardly be rewarding to attempt a classification at the intraspecific level.

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APPENDIX

The following herbarium specimens were used for the compilation of the distribution map of *Strelitzia* (Fig. 1):

S. alba

CAPE PROVINCE—3323 (Willowmore): Groot Rivier Pass (-CD), abundant on steep slopes and occasional in forest near streams, *Dyer 5329* (PRE); on eastern slopes, *Small and Robbertse 3* (PEU); in forest and on ledges of cliffs, *Keet s.n.* (GRA); Blauwkrantz (-DC), Groot Kloof, *Schmidt s.n.* (GRA); Storms River (-DD), on steep slopes of thickly wooded kloof, *Fourcade s.n.* (GRA).

S. caudata

TRANSVAAL—2329 (Pietersburg): Pietersburg (-DD), Woodbush Forest Station, *Grewcock s.n.* (PRE). Type: 2330 (Tzaneen): Zoutpansberg (-AA), from farm "Geluk", 23 km East of Louis Trichardt, *Veschuur s.n.* (PRE); Piesanghoek (-AA), amongst rocks in dense bush on summit and on rocks on bush-covered krans on mountainside, *Galpin s.n.* (PRE); Louis Trichardt (-AA), in Widdringtonia bush of Piesanghoek, *Gerstner 5784* (PRE); Westphalia (-CC), Pietersburg district, *Burtt-Davy s.n.* (PRE); Letaba (-CD), *Scheepers 428* (PRE). 2430 (Pilgrim's Rest): Pilgrim's Rest (-DD), *v.d. Schijff 6462* (PRE). 2531 (Komatipoort): Barberton (-CC), *Dyer 4802* (PRE).

SWAZILAND—2531 (Komatipoort): Pigg's Peak (-CD), *Heenan s.n.* (PRE).

S. juncea

CAPE PROVINCE—3324 (Steytlerville): Vensterhoek (-DD), on farm Vensterhoek, *Small and Robbertse 28* (PEU); *van de Venter 147* (PEU). 3325 (Port Elizabeth): Brackhill (-CB), on northern slope, *Small and Robbertse 6; 55* (PEU); Prentice Kraal (-CB), on northern slopes on side of Uitenhage—Jansenville road, *van de Venter 181* (PEU); Uitenhage (-CB), scrubveld 5 km from Uitenhage on Steytlerville road, *Admiraal 468* (PRE); 16 km from Uitenhage on Steytlerville road in Karroid scrub, *Dyer 4832* (PRE); *Dyer and Wells 5820* (PRE); on mountains, *Patterson 665* (GRA); Uitenhage, *Thode A 2752* (PRE); Port Elizabeth (-DA), on northern slopes in Gelanse Kloof, above Salsoniville, *van de Venter 213* (PEU); Bethelsdorp, *Patterson 665* (GRA).

S. nicolai

NATAL—2632 (Bela Vista): Zululand (-DD), Kosi Bay, *Rodni 4610* (PRE). 2732 (Ubombo): Ubombo (-CA), 12 km S.W. of Manzengwenya on road to Mbazwana, *de Winter and Vahrmeijer 8589* (PRE). 2831 (Nkandla): Hlabisa (-BB), *Ward 4417* (PRE). 2832 (Mtubatuba): Mtubatuba (-AC), coastal sandflats, scrub with scattered trees, Palm Ridge farm, *Harrison 414* (PRE). 2930 (Pietermaritzburg): Isipingobeach (-DD), *Ward 854* (PRE). 3030 (Port Shepstone): Margate (-CD), *Prosser s.n.* (PRE); Southport (-DA), *Bruce 437* (PRE).

CAPE PROVINCE—3228 (Butterworth): (-CC), on bank of lagoon, *van de Venter 60* (PEU).

S. reginae

NATAL—2831 (Nkandla): Nxeba Ridge (-BD), hill near junction of Black and White Umfolozi Rivers, *Barret s.n.* (PRE); Mpila Hill, Umfolozi Game Reserve (-BD), on steep slope amongst rocks, *Borquin 533* (PRE); Heatonville (-DB), on banks of spruit, *Houting s.n.* (PRE); Empangeni (-DD), in bush on banks of stream, *Houting s.n.* (GRA).

CAPE PROVINCE—3129 (Port St. Johns): Mtata River (-CC), short distance north of Coffee Bay on coast, *Vogts s.n.* (PRE). 3227 (Stutterheim): near East London—Nahoon road (-DD), *van de Venter 169* (PEU); Arnoldton (-DD) on farm "Fairview", *van de Venter 176* (PEU). 3228 (Butterworth): Kei Mouth (-CB), *Flanagan 1706* (PRE); 6 km from river mouth, *Small and Robbertse 21* (PEU); Cintsa (-CC), 5 km from coast on banks of stream, *Small and Robbertse 16* (PEU); Kwelera (-CC), on stream bank in shade of gully bush, 75 km from Kwelera on road to East London, *Comins s.n.* (GRA). 3324 (Steytlerville): Vensterhoek (-DD), on farm Vensterhoek, *Small and Robbertse 32;*

33; 150 (PEU); *van de Venter 149* (PEU). 3326 (Grahamstown): Ecca Pass (-BA), eastern slopes, *Small and Robbertse 8; 34* (PEU); Pluto's Vale (-BA), *Small and Robbertse 56; 57; 58; 170–174* (PEU); Kariege Rivier (-DA), im walde *Zeyher 3953* (GRA); Port Alfred (-DB), on banks of stream under dense bush, *Small and Robbertse 10* (PEU). 3327 (Peddie): Keiskamma River (-AB), 16 km from mouth in dense bush, *Small and Robbertse 11* (PEU); East London (-BB), hillsides along Buffalo River, *Galpin s.n.* (PRE); Keiskamma (-BC), *Sim 19927* (PRE).